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(54) A LAUNDRY WASHING MACHINE

(71) We, THOMSON-BRANDT, a French Body Corporate, of 173 Boulevard Haussmann, 75008 Paris, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present invention relates to a washing machine for washing laundry.

In known drum washing machines, the motors used to drive the drum are often two-speed asynchronous motors providing a slow speed for washing and a high speed for drying. At the moment when the pressure-sensitive device (pressostat) controlling the drying operation reaches its lowest point, practically all the water has been drained from the tank and the drum is turning at the washing speed, which may be of the order to 50 rpm. When the drying operation begins, the drum is accelerated to a high speed of rotation, which may be from 450 to 1000 rpm, in a time which varies from 1 to 2 seconds. The increase in the speed of the drum is so sudden that the laundry is forced too quickly against the wall of the drum and thus has no time to distribute itself properly in the drum. An imbalance is thus created in the drum, which is detrimental to the operation of the machine and which makes it necessary for the assembly to be suspended and reinforced and a cumbersome damper to be fitted. In addition the laundry is crumpled and very much squashed together. To overcome this latter drawback, in the initial drying phase when the water has been drained from the tank, the drum is driven intermittently, that is to say power is supplied to the drive motor for a certain length of time to allow it to drive the drum to a speed higher than the washing speed, and the power supply is then cut off for a certain length of time to allow the speed of the drum to drop below the washing speed, and so on. Whilst the speed of the drum is rising, the laundry is thrown onto and pressed against the drum wall and as the speed of the drum falls the laundry slides in a flattened-out state down from the upper to the lower parts of the drum under its own weight. A certain amount of tumbling of the laundry does take place, but this still does not ensure that the laundry is satisfactorily distributed in the drum given that the periodic change in speed does not effectively help the items of laundry to slide apart from one another.

Having begun with a periodic change in the speed of rotation in the drum, the drying operation continues with a sudden increase in the speed of rotation of the drum to a rate of the order of 500 rpm or above. In this phase of the drying operation a large amount of water is extracted from the laundry. The drain pump of the machine cannot remove all this water at once. The water which remains in the tank is carried round by the drum which at this time is revolving at a high speed, and forms a vortex which is out of the reach of the drain pump and which, in machines which have an access opening at the top causes an unpleasant noise when it strikes the joint which connects the tank to this access opening.

The present invention, which has as an object substantially to reduce or avoid the drawbacks above, enables an improved washing machine to be produced in which there is virtually no imblanace, nor vortex in the drum, and no great consumption of supply current in the course of the drying operation.

Accordingly in one aspect the present invention consists in a laundry washing machine having a tank, a pump for draining the tank, a laundry drum, a motor to drive the laundry drum, and a programme device to control the operations carried out by the machine, wherein the washing programmes include a drying operation which begins at the same time as begins the emptying of the supply of water in the tank and which includes at least a phase 1 in which some water is extracted from the tank and the speed of rotation of the drum increases

slowly from the washing speed to a speed of approximately 90 rpm, a phase 2 in which some water is still present in the tank and the speed of the drum is substantially constant and of the order of 90 rpm, a phase 3 in which the tank is practically empty of water and the speed of the drum is progressively increased to approximately 120 rpm by a combination of an increased supply of electricity to the drive motor and extraction of water from the laundry, and a phase 4 in which the speed of the drum increases to a speed of the order of 170 rpm solely because of reduction in weight caused by extraction of water from the laundry, with a dwell of a certain length of time at this speed before a possible entry into other phases in which the speed of rotation of the drum is higher.

In a second aspect the invention consists in a method of carrying out a drying operation in a laundry washing machine having a tank, a pump for draining the tank, a laundry drum, a motor to drive the laundry drum, and a programme device to control the operation carried out by the machine wherein the drying operation begins at the same time as beings the emptying of the supply of water in the tank and includes a phase 1 in which water is present in the tank of the machine and the speed of rotation of the laundry drum increases slowly from the washing speed to a speed of approximately 90 rpm, a phase 2 in which some of the water supply is still present in the tank and the speed of the drum is substantially constant and of the order of 90 rpm, a phase 3 in which the tank is practically empty of water and the speed of the drum progressively increasing to approximately 120 rpm by a combination of an increased supply of electricity to the drive motor and extraction of water from the laundry, and a phase 4 in which the speed of the drum increases to a speed of the order of 170 rpm solely because of reduction in weight caused by extraction of water from the laundry, with a dwell of a certain length of time at this speed.

In order that the invention may be better understood, there will now be described one embodiment thereof, with reference to the accompanying drawing which shows a pair of representative time-function curves, one of which relates to the amount of water (in litres) in the machine and the other of which relates to the speed of rotation, (in revolutions per minute) of the drum, during the operation of drying the laundry.

In a similar way to some known washing machines a washing machine according to the invention has a cabinet, a tank, a pump for draining water from the tank, a horizontal laundry drum, a DC motor to drive the laundry drum, and a programme device to control the operations carried out by the machine. The drive motor is a DC motor of known type which is able to rotate at any speed between zero and a speed equal to or greater than 800 rpm for example. The machine according to the invention washes laundry at a normal speed of the order of 50 rpm.

In one of the operating programmes which is used as an example, the washing machine according to the invention dries the laundry by a procedure which is indicated, in broad outline, by the accompanying representative curves. Curve ABCDEFGHIJK represents the speed of rotation of the laundry drum, as a function of time, from the beginning to the end of the drying operation, and curve MNOPQ represents the water in the machine from the beginning to the end of the drying operation.

In accordance with one of the important features of the invention, the operations of drying the laundry and emptying the tank begin at the same time. The tank then contains its full supply of water, which is of the order of 40 litres in the machine which is used as an example.

In phase 1 of the drying operation, which corresponds to part AB of the curve for drum speed and to part MN of the curve for water in the machine the laundry drum, churning through the supply of water in the tank, slowly increases its speed. During this first phase of the drying operation the motor driving the drum is supplied with a constant amount of power and as the resisting torque which has to be overcome decreases, the speed of the motor rises. In effect, the water in the tank sets up resistance to the rotation of the drum and thus to rotation of its drive motor. As the water is removed by the pump for emptying the tank, this resistance decreases and the resisting torque to be overcome by the drive motor likewise decreases. At the end of phase 1 of the drying operation, approximately a third of the total water supply in the tank has been removed and the speed of the laundry drum has altered from 50 rpm, which is the washing speed, to approximately 90 rpm. In this first phase of the drying operation a progressive increase in the drum speed is combined with a slow decrease in the water supply in the tank, a combination which allows the laundry to become well distributed in the drum and thus prevents an imbalance from being created. In effect, the items of laundry float and find it easy to slide over one another in a drum which is churning through the water supply, even though the latter is dropping progressively and the speed of the drum rises progressively to the distribution speed, which is of the order of 65 rpm and at which

the centrifugal force generated by the rotation of the drum is equivalent to the weight of the laundry; and then to the centrifuging speed, which is of the order of 90 rpm and at which the articles of laundry begin to be thrust against the wall of the drum. In phase 2 of the drying operation, which corresponds to part BC of the curve for drum speed and part NO of the curve for water in the machine, the speed of the drum is held steady at 90 rpm to prevent the laundry being pressed against the wall of the drum to an excessive degree, and the presence of a residue of water in the tank helps the articles of laundry to slip and assists in completing the distribution of the laundry in the drum. At the end of phase 2, the laundry still contains almost all of its water and the tank is practically empty. At phase 3 of the drying operation the drive motor is given an increased supply of electricity. During this phase water begins to be extracted from the laundry. As a result of the increased electricity supply to the motor and the extraction of the water from the laundry the rate of rotation of the drum increases progressively to 120 rpm. This third phase corresponds to part CD of the curve for drum speed. Phase 3 is followed by phase 4 in which the electricity supply to the drive resistor remains constant the speed of the drum rises slowly from 120 rpm to 170 rpm, as a result of a change in its load which is due to the loss of the water leaving the laundry and remains at this latter speed for a certain length of time. These phases 3 and 4 of the drying operation represent another important feature of the invention. In effect, in phases 3 and 4, which correspond to part CDE of the curve for drum speed and part OP of the curve for water in the machine, the laundry gives up a large proportion of its water but with the drum rotating only at slow speeds. The centrifugal force to which the laundry is subject is therefore low. It is still easy for the individual articles of laundry to slide. The laundry does not pack together and does not create an imbalance in the drum. Phases 3 and 4 thus assist not only in improving the distribution of the articles of laundry in the drum but also in lightening the rotating mass, i.e. reducing the resisting torque set up by the drum, and in preventing a vortex being formed around the drum or troublesome foam being formed if the water is soapy. In a washing machine foam and vortices are only formed when the drum is rotating at high speed. The drying operation next enters a phase 5 in which the drum, having been lightened by the weight of the previously extracted water, accelerates from its speed of 180 rpm to approximately 450 rpm, with a low or restricted constant acceleration. Given that torque is proportional to the rotating mass and inversely proportional to the runup period or the period taken to change speed ($T=I\alpha/t$, where T is torque I is the moment of inertia, α is the speed of rotation and t is the run-up time), in phase 5, if the time taken for the drum to speed up is increased, the torque necessary for accelerating the drum decreases and the extra supply current drawn by the drive motor decreases also. By applying low or restricted acceleration to the drum in phase 5, high current drain is avoided, as is likewise a high peak current in the circuit supplying the drive motor, which normally makes it necessary to have heavy duty components which are consequently costly. In phase 6 of the drying operation, which corresponds to part FG of the curve for drum speed, the drum revolves at approximately 450 rpm. Depending upon the nature of the laundry, the final part of the drying operation may take place at a speed lower than 450 rpm, or at a speed between 450 and 800 rpm, or at a higher speed. In the machine which is used as an example, after intermediate phase 6 of the drying operation, the final part of the operation takes place at a speed of approximately 800 rpm in a phase 7 which corresponds to part GHI of the speed curve and continues into a phase 8 which corresponds to part IJ of the speed curve, in which the rotation of the drum is slowed down rapidly, and concludes at a speed for loosening up the laundry which is equal to or lower than 50 rpm, in a phase 9, which corresponds to part JK of the speed curve.

The length of phase 1 of the laundry drying operation is a function of the load in the drum and the throughput of the drain pump, whilst the length of phase 2 preferably does not exceed one hundred and eighty seconds, that of phase 3 fifteen seconds, that of phase 4 sixty seconds, and that of phase 5 thirty seconds. The length of phases 6, 7, 8 and 9 may be adjusted by the user.

WHAT WE CLAIM IS:—

1. A laundry washing machine having a tank, a pump for draining the tank, a laundry drum, a motor to drive the laundry drum, and a programme device to control the operations carried out by the machine, wherein the washing programmes include a drying operation which begins at the same time as begins the emptying of the supply of water in the tank and which includes at least a phase 1 in which some water is extracted from the tank and the speed of rotation of the drum increases slowly from the washing speed to a speed of approximately 90 rpm, a phase 2 in which some water is still present in the tank and the speed of the drum is substantially

constant and of the order of 90 rpm, a phase 3 in which the tank is practically empty of water and the speed of the drum is progressively increased to approximately 120 rpm by a combination of an increased supply of electricity to the drive motor and extraction of water from the laundry and a phase 4 in which the speed of the drum increases to a speed of the order of 170 rpm solely because of reduction in weight caused by extraction of water from the laundry, with a dwell of a certain length of time at this speed before a possible entry into other phases in which the speed of rotation of the drum is higher.

2. A machine according to claim 1, wherein the length of phase 2 of the drying operation does not exceed one hundred and eighty seconds, that of phase 3 fifteen seconds, and that of phase 4 sixty seconds.

3. A machine according to claim 1 or 2 wherein a DC motor used to drive the drum is fed at constant power in phase 1 of the drying operation.

4. A machine according to claim 1, 2 or 3, wherein the drying operation includes, after phases 1 to 4, a rise in the speed of rotation of the drum from a speed of approximately 170 rpm to one of approximately 450 rpm which rise in speed occupies a length of time which does not exceed thirty seconds.

5. A machine according to any preceding claim wherein the drying operation concludes with a loosening-up phase in which the speed of rotation of the drum does not exceed 50 rpm.

6. A laundry washing machine having a drying programme substantially as hereinbefore described with reference to the accompanying drawing.

7. A method of carrying out a drying operation in a laundry washing machine having a tank, a pump for draining the tank, a laundry drum, a motor to drive the laundry drum, and a programme device to control the operation carried out by the machine wherein the drying operation begins at the same time as begins the emptying of the supply of water in the tank and includes a phase 1 in which water is present in the tank of the machine and speed of rotation of the laundry drum increases slowly from, the washing speed to a speed of approximately 90 rpm, a phase 2 in which some of the water supply is still present in the tank and the speed of the drum is substantially constant and of the order of 90 rpm, a phase 3 in which the tank is practically empty of water and the speed of the drum progressively increasing to approximately 120 rpm by a combination of an increased supply of electricity to the drive motor and extraction of water from the laundry, and a phase 4 in which the speed of the drum increases to a speed of the order of 170 rpm solely because of reduction in weight caused by extraction of water from the laundry, with a dwell of a certain length of time at this speed.

8. A method as claimed in claim 7, in which phase 4 is followed by one or more other phases in which the speed of rotation of the drum is higher that 170 rpm.

9. A method as claimed in claim 7 or 8, wherein the length of phase 2 of the drying operation does not exceed one hundred and eighty seconds, that of phase 3 fifteen seconds, and that of phase 4 sixty seconds.

10. A method as claimed in claim 7, 8 or 9 wherein the motor used to drive the laundry drum is fed at constant power in phase 1 of the drying operation.

11. A method as claimed in claim 8, wherein the drying operation includes, after phases 1 to 4, a rise in the speed of rotation of the drum from a speed of approximately 170 rpm to one of approximately 450 rpm which rise in speed occupies a length of time which does not exceed thirty seconds.

12. A method as claimed in any of claims 7 to 11 wherein the drying operation concludes with a loosening-up phase in which the speed of rotation of the drum does not exceed 50 rpm.

13. A method of carrying out a drying operation in a laundry washing machine subsantially as hereinbefore described with reference to the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*